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Reference

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The title of invention	THE METHOD OF CONSUMABLE ELECTRODES MANUFACTURE FROM METALLIC CHIPS.
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THE METHOD OF CONSUMABLE ELECTRODES MANUFACTURE FROM METALLIC CHIPS.

МПК C22B 9/20

The present invention relates to metallurgical recycling of engineering industry waste products, preferably chips, in particular, titanium alloys chips. The product of processing in the form of consumable electrodes can be used for secondary titanium alloys manufacture, as well as in ferrous metallurgy for steel alloying.

The most commonly known (about 45% of the total amount of factory metallic waste products) and the most difficult to be recycled sort of waste products is chip scrap, the difficulty of preparation of which for recycling consists in it's great volume, contamination with emulsion, technical oil contamination, as well as contamination with foreign particles of another metals and hard alloys. At present time only minor amount of chip scrap waste products is recycled, the greater part of it is utilized with violation of environmental requirements and without deriving economic benefits.

The well-known method for producing consumable electrodes using 10 - 15% of chip scrap, and the rest is – titanium sponge /1/, is characterized in that, at first briquettes are pressed, further said briquettes are welded in argon into consumable electrode. The disadvantage of said method is use of a considerable amount of expensive titanium sponge, and insufficient mechanical strength of the electrodes, which can lead to destruction thereof during refining.

The well-known manufacturing process for obtaining consumable electrodes /2/ from foundry titanium bulk scrap and briquetted chip scrap by packing bulk scrap and chip scrap briquettes into a mould with further filling up the mould with liquid alloy of the same name, which fills interstice between the scraps and briquettes and forms a consumable electrode. The main disadvantage of said analogue is small portion of chip scrap waste products used, since considerable

party by weight of (furnace) charge is filled up with bulk scrap, alloy and titanium sponge.

The well-known method for producing consumable electrodes /3/ by filling up with like alloy titanium bulk scrap and chip scrap briquettes placed into a mould (the share of chip scrap in a (furnace) charge is 5 - 10 %). The disadvantages of said analogue are as follows: low rate of chip scrap waste products used, and considerable oxygen content in the ingot obtained after remelting the electrode manufactured in accordance with said process, since owing to chip scrap contamination in case of one per cent increase of number of briquettes in (furnace) charge results in oxygen content rise in secondary alloy by 0,008 %.

The most similar to the analogue and results thereof is the process for producing consumable electrodes from titanium and alloys thereof /4/, mainly from scrap, clipping and chip scrap. The process is characterized in that preliminarily preparation of (furnace) charge, its placing into a mould and filling up with molten alloy is carried out. When a (furnace) charge is used in form of chip scrap briquettes, said chip scrap briquettes are loaded into the mould with clearance, which provide mould volume infill with molten metal; and before filling up the mould is heated up to 300 - 350°C. Furthermore, depending on charging volume of the mould with (furnace) charge different methods for filling in molten metal are used. Said process has the same disadvantages as analogues thereof, in the main, low rate of chip scrap waste products used in metallurgical recycling and considerable interstitial impurities content such as carbon, oxygen, hydrogen and nitrogen which lead to mechanical degradation of secondary alloys, obtained after remelting the electrodes. Moreover, deficient heating of the mould before infill can result in crumbling of chip scrap during electrode refining because of weak diffusion adhesion of briquettes' material and molten alloy.

It is an object of the invention to provide 100% involving chip scrap into metallurgical recycling, excluding from the consumable electrodes production process expensive titanium sponge, to increase mechanical strength of the

electrodes and to improve secondary alloys due to interstitial impurities content reduction.

This problem is solved by that during consumable electrodes production process chip scrap is subjected to crushing, cleaning, vacuum-thermic degassing (VTD) at the temperature of 550 - 650 °C and holding for 1-2 hours, further chip scrap is pressed to form cylindrical shape briquettes, which are placed into the mould with clearance, which provide infill with molten metal thereof; and before filling up the mould is heated up to 400 - 450°C. The clear difference of this process consists in conducting VTD of chip scrap prior its pressing to form briquettes and heating the mould up to 400 - 450°C together with briquettes loaded into said mould, and also that the cold molding of the briquettes is carried out up to relative density of 0,6- 0,75 when the ratio of briquette height to its diameter is from 0,5-3, at that the diameters of briquettes which are loaded into said mould are identical, the ratio of briquettes diameter to internal mould diameter is 0,8-0,9, briquette with maximum relative density is placed on the bottom of the mould, and for subsequent electrode manufacture the previous electrode is used, said electrode is melted in the amount equal to the quantity (mass) of alloy filled into the mould during the previous electrode manufacture.

Optimal flowsheet and conditions of process realization are determined experimentally. During VTD dirt is removed from the surface of chip scrap, deformation cold-hardening formed during machining of the alloy and chip scrap crushing is cut off, as a result of it chip scrap pressing effort is reduced by 20-30% (at prescribed briquette density). The temperature of degassing from 550°C to 650°C under holding for 1-2 hours provides greatest effect of gas dirt removing and chip scrap surface microhardness (cold-hardening) lowering, rise in VTD temperature over 650°C and holding for over 2 hours is not economically sound because of considerable power inputs. Mould heating up to 400 - 450°C is determined by necessity of creation of maximum adhesion of chip scrap briquettes' material and like alloy filled in. The relative density of briquettes in range of

0,6-0,75, the casting clearance size of from 0,8 to 0,9 of briquettes' diameter to internal mould diameter ratio, the ratio of briquette height to its diameter selected from the range of 0,5-3, and placing a briquette with maximum relative density on the bottom of the mould, said conditions are selected for providing sufficient mechanical strength of consumable electrodes and taking into account casting characteristics of alloy filled into the mould.

The process is conducted in the way as follows. The chip scrap, predominantly, of titanium alloys, is crushed in hammer crusher 188 ДР type to obtain particles of (5 - 10) • (5 - 20) mm particle size and washed in degreasing solution, for example, comprising 30- 35 g/l of soda ash and 15 - 20 g/l of trisodium phosphate at the temperature of 60 - 80°C, further it is washed in water and dried at the temperature of 200°C, then dry chip scrap is subjected to magnetic separation with ПБСЦ 40/10 type device.

Thus prepared chip scrap is placed into thermic furnace for VTD under residual pressure in furnace chamber of 5 • 10^{-3} millimeters of mercury, at temperature of 550 - 650°C and holding for 1-2 hours. The chip scrap cooling till 200°C is carried out with conservation of working pressure in furnace chamber, and final cooling is executed together with furnace when vacuum pumps are cut off.

For technical results demonstration VTD of two chip scrap sample parties from BT 1-0 and BT5 alloys 40 kg each was carried out. Chip scrap grade of quality corresponded to 1-st and 2-nd gr., П (second) chop according to GOST (National Standard) 1639-93. Gas impurities content such as carbon, oxygen, hydrogen and nitrogen and microhardness of chip scrap particles were determined prior and after VTD. For determination of said operation features 5 to 10 preforms from each chip scrap sample party were taken and the obtained results were averaged over. Carbon content was determined by coulometric titration according to GOST (National Standard) 9853.3 – 86, oxygen content – by melting the preform in an inert gas according to GOST (National Standard) 28052-89, hydrogen – by spectral-isotope method according to GOST (National Standard) 24056-81 and nitrogen – by

titrating method according to GOST (National Standard) 9853.1-79. Microhardness was determined by Vickers method. The results are given in Tab.1.

Table 1

Alloy grade	VTD tempera-ture,°C	Carbon weight, %	Oxygen weight, %	Nitrogen, weight, %	Hydrogen weight, %	Microhard-ness, units
BT1-0	—	0,15	0,2	0,03	0,005	310
BT1-0	550	0,028	0,12	0,022	0,0019	270
BT1-0	600	0,025	0,14	0,02	0,0016	280
BT1-0	650	0,029	0,15	0,02	0,0017	270
BT1-0	700	0,03	0,13	0,018	0,0015	260
BT5	—	0,08	0,15	0,02	0,003	350
BT5	500	0,025	0,12	0,015	0,0025	320
BT5	550	0,02	0,11	0,011	0,0078	300
BT5	600	0,018	0,11	0,014	0,0015	310
BT5	650	0,015	0,1	0,012	0,0014	290
BT5	700	0,012	0,08	0,01	0,0013	280

The analysis of the obtained results (Table 1) shows, that VTD allows to reduce gas impurities content on average for carbon by 80%, for oxygen and nitrogen by 30% and for hydrogen by 60%, and microhardness of chip scrap particles on average by 10-15%. After VTD cold molding of chip scrap briquettes on press with an effort of 1,6 MH with unidirectional circuit of application of pressing effort is carried out.

Example. Briquettes having the diameter of 100 mm were made, said briquettes were placed into metallic retractable ingot mould with internal diameter of 120 mm and filled up with like alloy in vacuum-arc skull furnace. The heating of the mould up to 400-450°C was carried out directly in the furnace, and as like alloy for manufacture of primary electrode foundry waste in the amount of no more than

50% of the manufactured primary electrode weight was used.

After pouring primary consumable electrode having diameter of 120 mm, height of 300 mm and weight of about 12 kg was obtained. The volume infill of the electrode with chip scrap briquettes came to 70%, by weight 61% (when relative density of briquettes of 0,7). For obtaining second electrode the primary one was used, said electrode was melted by weight of about 40%, the rest part of it was used for next electrode manufacture.

Altogether using the original sample parties of titanium chip scrap three electrodes were obtained from each party, said electrodes were weld in inert atmosphere and remelted using vacuum-arc fusion method in order to obtain ingots.

Chemical composition and stress-strain properties of the obtained ingots are given in Table 2.

Table 2

Ingot from alloy %	Al, %	Fe, %	Si, %	C, %	O, %	N, %	H, %	Breaking point, MPa	Tensile strain, %	Impact elasticity, kJ/m^2
BT1-0	-	0,4	0,25	0,08	0,25	0,05	0,01	800	10	300
BT 5	4,5	0,5	0,3	0,1	0,25	0,08	0,01	950	8	350

The obtained consumable electrodes with 100 % use of chip scrap and secondary titanium alloys manufactured from them using skull fusing method illustrate availability of further development of the method claimed for solving the problem of materials recovery. In spite of the fact that secondary alloys have an excessive to a certain extent interstitial impurities content in comparison with regular alloys, according to their physical and mechanical figures and economic indicators they can be extensively used in different branches of engineering.

(56) Source information:

1. Kiparisov S. S. and others. Titanium scrap processing, M., 1984, issue 1.

2. Filin Yu. A. and others. Processing and use of titanium waste products in foundries., jorn. "Liteinoe proizvodstvo", 2000, № 7, p.21.

3. Abramova K. B. and others. Briquetting of titanium chip scrap under the influence of electric current sharp pulses., jorn. "Tsvetnye metally", 1998, №12, p. 70 - 74.

4. Patent RF №2081727, B22Д 27/00, 1997, БИ№17.

CLAIMS

1. The method of consumable electrodes manufacture from metallic chips, preferably, from titanium alloys metallic chips, comprising crushing and cleaning of chip scrap, pressing of cylindrical shape chip scrap briquettes, placing said briquettes into the mould with clearance, which clearance provides mould infill with molten metal; and heating the mould before filling up with like alloy, *characterized in that* before pressing of briquettes chip scrap is subjected to vacuum-thermic degassing (VTD) at the temperature of 550 - 650 °C and holding for 1-2 hours, and the mould is heated up to 400 - 450°C.

2. The process in accordance with Claim 1, *characterized in that* pressing of chip scrap briquettes is carried out up to relative density of 0,6- 0,75 when the ratio of briquettes' height to their diameter is from 0,5-3,0.

3. The process in accordance with Claim 1, *characterized in that* the diameters of briquettes which are loaded into the mould are identical, and the ratio of briquettes' diameters to internal mould diameter is 0,8-0,9.

4. The process in accordance with Claim 1, 3, *characterized in that* when loading the mould the briquette with maximum relative density is placed on the bottom of said mould.

5. The process in accordance with Claim 1, *characterized in that* for subsequent consumable electrode manufacture the previous electrode is used, said electrode is melted in the amount equal to the quantity (mass) of alloy filled into the mould during the subsequent electrode manufacture.

THE ABSTRACT

The invention "The method of consumable electrodes manufacture from metallic chips."

The present invention relates to metallurgical recycling of waste products, preferably titanium alloys chips scrap.

The essence of the method is characterized in that, after crushing and cleaning the chip scrap is subjected to vacuum-thermic degassing at the temperature of 550 - 650 °C and holding for 1-2 hours, further chip scrap briquettes are pressed and placed with clearance into the mould, which mould is heated up to 400 - 450°C before filling up with like alloy.

The technical result is 100% use of chip scrap when secondary cast alloys are obtained. Claim 1c. and 4 з. of Claims.